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1994-95 School Year

Chemistry 30 Information Bulletin

Diploma Examinations Program

Students First!
Student Evaluation

Alberta
EDUCATION

This document was written primarily for:

Students	✓
Teachers	✓ Chemistry 30 teachers
Administrators	✓
Parents	
General Audience	
Others	

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Purpose of the Bulletin

The purpose of science bulletins is to provide students and teachers of the sciences with information about the diploma examinations scheduled for 1995. Science bulletins include descriptions of the examinations in the sciences that will be administered in January, June, and August of 1995; they outline the objectives to be tested and provide information about the design of the examinations. They provide guidelines for completing the machine-scored answer sheets, use of calculators, and the manipulation of data. Definitions of directing words, which are used to convey expectations for students' responses to exam questions, are given in the appendices along with suggestions for students when preparing for writing diploma examinations.

The bulletins describe the acceptable standard and the standard of excellence for Biology 30, Chemistry 30, Physics 30, and Science 30. These descriptions will give readers a general impression of the levels of achievement expected of students in each of the 30-level science courses.

The revised courses in Biology 30, Chemistry 30, and Physics 30 are being implemented this school year (1994–95). The revisions in these courses have implications for the design of the corresponding diploma examinations. Specific information concerning achievement expectations, sample questions, scoring criteria, and sample answers are provided in the bulletin for each of these courses.

The new Science 30 course is also being implemented this school year. All schools that offer the Science 30 course will be provided with year-end pilot tests. These tests will be prototypes of the Science 30 diploma examinations that will be administered starting the following school year (1995–96). Specific information concerning achievement expectations, sample questions, scoring criteria, and sample answers are provided in the bulletin for Science 30.

The Science 30 year-end pilot tests will be written according to the 1995 Diploma Examination Schedule, scored in the schools, and then returned to Alberta Education. The students' final course marks will be awarded by the school and will incorporate a 25% minimum weighting of the pilot test score. Students' marks on year-end pilot tests will not be reported separately to Information Services.

Inservices and Presentations

On a limited basis and subject to budget constraints, Student Evaluation Branch staff is available to provide inservices or presentations related to diploma examinations or the interpretation of diploma examination results.

If you have requests, questions, or comments about the contents of this bulletin, please contact:

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General Information

1995 Grade 12 Diploma ExaminationsSchedule

Date	*Time**	*Examination*
Thurs., Jan. 26	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30
Fri., Jan. 27	9:00–11:30 A.M.	Chemistry 30
	1:00–3:30 P.M.	Science 30 Pilot
Tues., June 27	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30
Wed., June 28	9:00–11:30 A.M.	Chemistry 30
	1:00–3:30 P.M.	Science 30 Pilot
Tues., Aug. 15	1:00–3:30 P.M.	Chemistry 30
Wed., Aug. 16	1:00–3:30 P.M.	Science 30 Pilot
Thurs., Aug. 17	9:00–11:30 A.M.	Biology 30
	1:00–3:30 P.M.	Physics 30

*The diploma examinations are designed for a writing time of 2.5 hours. Students will have an additional 0.5 h to complete the examinations.

There are no changes to the examination requirements. It is expected that 2.5 hours is adequate for each examination; however, the extra 0.5 hour is available for those students who need it.

1995 Marking Information

The written-response questions of the diploma examinations in the sciences are marked by classroom teachers. These markers are selected from teachers who have been recommended by their superintendents. To qualify for recommendation in all subjects except Science 30, a teacher must have taught the subject for two or more years, be currently teaching the subject, and have an Alberta Permanent Professional Certificate.

For Science 30, a teacher must have taught the subject previously or be currently teaching the subject, and have a valid Alberta Permanent Professional Certificate.

The following criteria are considered when markers are selected for a particular marking session:

- experience as a marker (generally, first-time markers are given priority)
- regional representation (by zone, jurisdiction, and school)
- student population (proportional representation
- gender balance

We particularly need teachers who can mark examinations written in French.

Teachers who wish to be recommended as markers for the January 1995 examinations should contact their superintendents before October 1, 1994. Teachers who wish to be recommended as markers for the June and August 1995 examinations should contact their superintendents before March 1, 1995

Tentative dates for marking of the 1995 science diploma examinations are:

January Administration	February 7 to 11
June Administration	July 10 to 14
August Administration	August 18 to 19

1994–95 Field Testing and Item Writing

As the need arises for teachers to participate in field testing and item writing, letters are sent to superintendents requesting their nominations. Teachers who are interested in these activities should let their superintendents know early in the school term.

Format of the Sciences Examinations

All examinations in the four sciences have both machine-scored questions and teacher-scored (written-response) questions.

The machine-scored questions are of two types: multiple-choice and numerical-response. Please refer to the *Chemistry 30 Information* section of this bulletin for further details about numerical-response questions.

Each examination in the sciences has two written-response questions. At least one of these will be an open-response question. Students' answers to open-response questions are scored by teachers using holistic scoring guides. These guides describe the characteristics of students' answers that correspond to one of five values: 0, 1, 2, 3, or 4. Each student's answer is scored independently by two teachers. The two sub-scores are added together for a combined total raw score.

The other written-response question on each examination may be a closed-response question. Students' answers to closed-response questions are scored by teachers using analytical scoring keys. Each student's answer is scored by only one teacher.

Examination questions may be organized into related sets. A set may be introduced by a general scenario that serves as an organizer for one or more contexts. This introductory statement will be screened.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

If required, a screened bar will indicate the end of a set.

A separate data booklet is provided for the Chemistry 30 and Science 30 (Pilot) examinations. The Biology 30 and Physics 30 examinations contain tear-out data pages. All examinations in the four sciences have tear-out pages for rough work.

Assessment of Skills and STS Connections

Students' understanding of the concepts of science are measured by every question on the examinations. In addition, some questions measure the students' development of the skills and thinking processes associated with scientific inquiry. Some questions will measure students' understanding of the interrelationships between science and technology and among science, technology, and society.

Communication skills are assessed most directly in the teacher-scored questions. For some closed-response questions, in addition to the analytical scoring key, a separate holistic scoring guide may be used. For the open-response questions, the descriptions used in the holistic scoring guides may include criteria for assessing communication skills along with criteria for the other components. Examples of scoring criteria can be found on page 23.

The term *communication skills* includes those processes by which information is exchanged through appropriate conventions. These conventions include:

- words, sentences, paragraphs
- graphs, diagrams
- mathematical formulas, mathematical and chemical equations
- significant digits, units of measurement

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Standards

Standards in education are statements that communicate the level of performance necessary to attain a specific goal or objective. Standards assist educators in determining the extent to which students must know content and demonstrate required skills to pass the course.

Standards of student achievement are described in general at the beginning of the *Chemistry 30 Information* section. These standards are applicable to students who attain the *acceptable* standard (a final mark of 50% or higher) and to students who attain the standard of *excellence* (a final mark of 80% or higher).

A more detailed description of specific learner expectations (standards) accompanied by sample questions, answers, scoring criteria, and samples of student responses is given in the *Sample Test Items, Scoring Criteria, and Sample Answers* section.

Use of Scientific Calculators on Examinations

Examinations are constructed to ensure that the use of particular scientific calculators neither advantages nor disadvantages individual students.

Please refer to Appendix A for the policy statement on the use of scientific calculators on diploma examinations. Also consult the *Chemistry 30 Information* section. Students should be made aware of this policy as early as possible in the school term to ensure they are able to use the scientific calculator of their choice when writing examinations.

Students should also be made aware of the Examination Rules, Grade 12 Diploma Examinations (see Appendix B). Students should know that notes stored in electronic devices may not be brought into the examination room.

Rescores

A student may request a rescoring of the diploma examination if he or she believes that the mark received is not appropriate. However, before applying for a rescoring, it is important to check the distribution of marks in the examination. The machine-scored mark is not likely to change as a result of a rescore, but the written-response mark could change slightly. Students should remember that the rescored mark will be the final mark whether it *increases* or *decreases*.

Examiners' Reports

Following the administration of the January and June examinations, examiners' reports are released. These reports briefly outline the statistical data obtained from the examination administration and provide a diagnostic overview of student performance. Examiners' reports are designed for teacher use. If we can make these reports more useful to you, please let us know.

School and Jurisdiction Statistical Reports

Superintendents and principals receive detailed statistical reports on how well the students in their school district did on the sciences examinations. Teachers use these data to reflect on the areas of the program where their students did well and those areas where student performance was poor.

Annual Report

A document entitled *Annual Report, Diploma Examination Program,* that summarizes results from the January, June, and August diploma examination administrations is published each year. The purpose of this report is to inform educators and the public about student achievement in relation to provincial standards.

Chemistry 30 Information

Standards

Students of Chemistry 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of chemical concepts, their increased ability to apply these concepts to relevant situations, and their ability to communicate in the specialized language of chemistry.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, and in particular by the successful completion of Science 10 and Chemistry 20.

Students who attain an *acceptable* standard of performance in Chemistry 30 receive a final mark of 50% or higher. These students can demonstrate a basic understanding of the nature of scientific investigation by designing and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs and tables, and can translate symbolic representations into word descriptions. They can readily recognize and provide definitions for key chemical terms. They can predict the physical and chemical properties of compounds. These students can demonstrate an acceptable level of understanding of chemical concepts by performing routine stoichiometric problems that do not involve multiple steps. They are capable of balancing an equation (combustion, formation, neutralization, or redox) and of solving the standard stoichiometric problems based upon these equations. Following the directions in laboratory procedures does not present a problem for these students, nor does using the data booklet to extract valid information. These students can compose clear and logical descriptive or explanatory statements to answer closed questions that do not involve more than one chemistry concept.

Students who attain a standard of *excellence* in Chemistry 30 receive a final mark of 80% or higher. In addition to meeting the expectations for an acceptable standard of performance, these students demonstrate an interest in chemistry and feel confident about their abilities. They can readily interpret interrelated sets of data such as complex graphs and tables. When presenting scientific data, they select the most appropriate form. These students can analyze and evaluate experimental designs. They can create their own laboratory procedures when given a clear definition of a problem. They can recognize weaknesses in laboratory work and can find ways to correct the weaknesses. They can write their own equations for formation, combustion, neutralization, and redox reactions, and can solve many variations of stoichiometric problems based upon these equations, including equilibrium expressions. They are able to transfer what they see happening in a test tube into equation form and are able to express scientific ideas clearly. They can usually cope with problems that involve overlapping of two or more concepts. The most significant characteristic of this group is that they can solve problems of a new and unique nature and can extrapolate these solutions to higher levels of understanding. Open-ended questions are not a problem for them. These students can communicate clearly and concisely, using appropriate scientific vocabulary.

Examination Specifications

Each Chemistry 30 Diploma Examination is designed to reflect the *Chemistry 30 course* general learner expectations outlined in the *Chemistry 20–30 Program of Studies, Interim, for Senior High Schools*. The general learner expectations are expressed in more detail by the specific learner expectations, which are organized into three units. Some questions on each diploma exam will assess achievement of specific learner expectations and some will be based on the integration of the specific learner expectations.

Knowledge ***Emphasis***

100%

The student can:

- apply conservation of matter and energy to changing systems; use evidence and knowledge to predict outcomes in a broad range of reactions
- analyze and evaluate physical, chemical, and biological systems in terms of energy, matter forms, transfers, movement and conservation
- explain the relationships in physical, chemical, and nuclear changes through the rearrangement of bonds and the resulting release or absorption of energy
- quantitatively and qualitatively explain and analyze the transfer of electrons and the associated transformations that take place in electrochemical systems
- quantitatively and qualitatively describe equilibrium systems for acids, bases, and gases and some of their applications
- quantitatively and qualitatively describe acids and bases in physical and conceptual terms (Brønsted-Lowry)

Skills ***Emphasis***

20 to 40%

The student can:

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Connections Among Science, Technology, and Society (STS) ***Emphasis***

20 to 40%

The student can:

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory; and explain the limitations of science and technology in answering questions and solving problems
- describe and evaluate the design and function of technological solutions to theoretical and practical problems; and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society; assess the ability to interact responsibly with the environment
- apply the skills and knowledge acquired in science to everyday life

Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the examinations. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics; this is also true of the STS component.

Integration of General Learner Expectations (GLEs)

Some question sets are contextual and thus may integrate several GLEs. All questions will measure achievement of scientific knowledge; some will also measure achievement of skills and /or STS connections.

Examination Design

The design of the 1995 Chemistry 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	44	55
Numerical Response	12	15
Written Response	2	30

The examination is composed of multiple-choice, numerical-response, and written-response questions. Both the numerical-response and written-response questions are distributed among the multiple-choice questions.

Multiple-choice questions are of two types: *discrete* and *context-dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. The context-dependent question provides information separate from the question stem. Some of the multiple-choice questions are *discrete* but most of the multiple-choice questions are *context-dependent*.

A particular context may be used for more than one multiple-choice question as well as for one or more numerical-response question. Answers for multiple-choice questions are recorded in the multiple-choice section of the machine-scored answer sheet and answers for numerical-response questions are recorded in numerical-response section of the same machine-scored answer sheet.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered items from a list, and determination of a sequence of items. Two or more of these questions may be linked together. Thus the student answer to the preceding question will form the basis of the "correct" response to the question and any that follow.

The teacher-scored portion of each examination, consists of two questions: a closed-response and an open-response question. Each question has a value of 15 percent.

The closed-response question presents a the student with a problem which may include pertinent data in the form of graphs and/or tables. There may be several parts to this question that requires the student to demonstrate a variety of science process skills. The teacher who marks this question will use an analytical scoring guide. This question may be located any where in the test, but will normally be found near the end of the examination.

The open-response question presents a problem, the solution of which requires making connections between chemical concepts, technology and/or social issues. Furthermore, an acceptable response will demonstrate good communication skills. Each student's answer to this question is scored independently by two teachers. Holistic guides are used to score a student's response.

The two sub scores are added together for a combined total raw score. An example of this type of question with the scoring criteria can be found on page 23 and sample responses found on pages 24 to 31. This question will be normally found at the end of the test.

Emphases in the 1995 Examinations

- We will continue to evaluate written-response questions on how well the answer is communicated.
- Some questions will include concepts from more than one of the units.
- Written-response questions will require students to see relationships among concepts learned and require students to supply appropriate contexts.
- Some questions will require students to apply what they have learned to new contexts.
- Written-response questions may require students to write balanced chemical equations including correct states of matter.
- Students are expected to devise a balanced half-reaction in acid or neutral solution.
- Students are expected to balance an auto-oxidation (disproportionation) reaction given the reagents involved.
- Numerical answers are to be rounded only once, at the end of the question. Intermediate numbers are to be used as displayed on the students' calculator.
- Students are expected to use the appropriate SI notation in their responses. A list of these symbols can be found in the new data booklet.
- Students will not be expected to solve questions utilizing $\Delta E_p = vc\Delta t$. This requires the use of density and implies that a volumetric measure, such a gas volumes, would be appropriate. The expansion of the curriculum through this interpretation is not appropriate or valid. This concept is also flawed, in that specific heat capacity is a measure based only on mass and hence "*vc*" has no meaning. Additionally, the use of volume is problematic in that volume is temperature dependent, like "*c*."
- The diploma examination treats the terms "oxidation number" and "oxidation state" as synonyms. Students are expected to assign oxidation numbers to hydrides and peroxides.
- The diploma examination will define "electrochemical cells" as either Voltaic cells or electrolytic cells. The term galvanic will not be used on the diploma examination.
- Students will not be expected to solve questions utilizing the quadratic equation. However, it is expected that the student set up the relationship correctly and that only when the mathematical operation is to take place is a statement about approximation to be made and used.
- Students are expected to know that the term amphiprotic is a synonym for amphoteric and thus either term may be used on diploma examinations.
- The diploma examination will treat the terms *equivalence point* and *end point* as follows:

> Equivalence point is the point at which chemically equivalent amounts have been added. Thus a "diploma-type question" may ask students to *indicate on the graph where the equivalence point for the reaction occurs*. The rationale for this is that the question is about completion of the reaction. The term end point really has no meaning unless it is within a context; for example, *. . . 40.2 mL was used to titrate the sample to the green*

bromothymol blue (indicator)
end point.

- The diploma examination will treat the terms precision, readability, and accuracy in the following manner, as defined by IUPAC:

> Precision refers to the reproducibility of measurements and not to "the place value of the last digit obtained in a measurement. The last place value of a measurement is the readability of the balance/ measuring instrument. The term accuracy refers to the difference between a result and the true value.

- Students will not be expected to solve questions using percent reaction.

Changes to the Field Tests

Field tests for students will **focus** mainly on questions involving new concepts or question formats. All questions will require the use of the new yellow data booklet.

There will be an opportunity for students at the Chemistry 20 level to participate in the field testing of a 2.5 h year-end examination. This examination will have the same format and structure as the Chemistry 30 Diploma examination. These field tests will be available in January and June.

Conventions (Skill) Assessment of Written Responses

The intent of evaluating communication is to reward students for creating responses that are on topic, clear, concise, and well written using the conventions of scientific language. Conventions (skill) assessment on the chemistry diploma examinations will focus on three main criteria.

Firstly, the response must address the question asked and appropriately apply concepts learned in Chemistry.

Secondly, the response must be expressed clearly and logically, and be organized in a meaningful manner.

Thirdly, the response must use the conventions of science accurately.

Markers of the 1994 Chemistry 30 diploma examinations again made the following comments about communication conventions:

- "shorthand" should not be used for written responses because there is no guarantee that a specific teacher's/ student's shorthand notation will be understood by all markers
- the "box" method of stoichiometry is **not** an acceptable method of communicating an answer and should not be used in the written-response section of the examination
- proper terminology should be used; for example, pH not Ph, molar heat (enthalpy) of reaction not reaction heats

Calculators

The only type of calculator allowed for writing the chemistry diploma examinations will be a **scientific** calculator. Note that programmable features **are not** required. It is strongly suggested that students read the calculator policy on page 32 and the examination rules on page 33.

Changes to the Chemistry Data Booklet

The new data booklet has a yellow cover and contains colour photographs. Sample copies are being sent to each school. Additional copies may be purchased from the Learning Resources Distributing Centre (403-427-2767). Changes to the booklet are listed below.

- The entire booklet has been reordered to match the new program of studies.

- A periodic table is now printed in colour and has the atomic molar mass of gallium corrected to 69.72

- A new chart of Chemistry Notation has been added.

- The specific heat capacity of air, mass of one mole of air, gas constant, Ideal Gas Law, and quadratic equation have been added to the Miscellaneous section.

- A Flame Colours of Elements chart replaces the Common Aqueous Ion chart. Note: This chart is intended to help students answer questions and is not expected to be part of student knowledge for the purpose of testing.

- The electrical potential for the dichromate half reaction has been corrected to 1.33 V. The notation concerning strength of oxidizing/reducing agent has been removed from the table. Note: There is an error on the new table—$Sn_{(aq)}$ should be $Sn_{(s)}$.

- Cresol red has been added to the Acid-base Indicator table.

- The Strengths of Acids and Bases table is new. Benzoic acid, orange IV, phenol red, and indigo carmine have been added while hydroxide ion and percent dissociation with water have been removed from the table. Note: There is an error on the table—$HCIO_{4(aq)}$ should be $HClO_{4(aq)}$.

- A new colour plate of common aqueous ions appears. Note: There is an error on the plate—cobalt should be cobalt(II).

- In addition to the table of indicators, a new colour plate of acid-base indicators appears.

Examples of New Question Formats and Instructional pages

The series of questions that follow are presented in the form of a test to exemplify the new question types and the format of the diploma examination. In addition, these questions have been selected to demonstrate expectations of the standard of excellence and the acceptable standard.

Special Instructions

Chemistry 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

Total possible marks: 80

This is a **closed-book** examination consisting of parts:

- 44 multiple-choice and 12 numerical response questions each with a value of one mark.
- 2 written-response questions for a total of 24 marks.

This examination contains sets of related questions. A set of questions may contain multiple-choice and/or numerical-response and/or written response questions.

A chemistry data booklet is provided for your reference.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Carefully read the instructions for each type of question before proceeding.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Do not fold the answer sheet.

Multiple Choice

- Use an HB pencil only for the machine-scored answer sheet.
- If you wish to change an answer, erase all traces of your first answer.
- Decide which of the choices **best** completes the statement or answers thequestion.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. chemistry
B. biology
C. physics
D. science

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

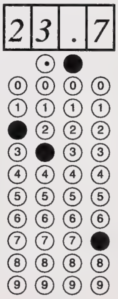
- Read each question carefully.
- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- Use an HB pencil only for the machine-scored answer sheet.
- If you wish to change an answer, erase all traces of your first answer.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

Examples
Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is ________.
(Record your answer to three digits.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet ⟶



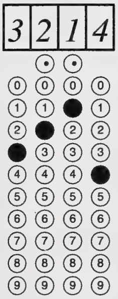
Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is__________. (Record all four digits.)

1 physics
2 chemistry
3 biology
4 science

Answer 3, 2, 1, 4

Record 3214 on the answer sheet ⟶



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers **must show all** pertinent explanations, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences for a written response, and correct units and significant digits for a numeric response.

Note: *The perforated pages at the back of this booklet may be torn out and used for your rough work.* ***No marks*** *will be given for work done on the tear-out pages.*

Do not turn the page to start the test until told to do so by the presiding examiner.

Sample Test Items, Scoring Criteria, and Sample Answers

Sample Test

This shaded text indicates that there are a series of questions to follow which are based upon the scenario/context/STS introduction. In this case, there is a series of questions based upon the chemistry involved in the making of ice tea in the home.

Iced tea has become very popular over the last several years. As a result, there are many manufacturers producing and selling ice tea products. Unlike most "pops," ice tea is easily prepared at home. In order to prepare iced tea from scratch, the following steps are involved:

Step	Procedure
I.	A kettle containing cold water is plugged into an electrical outlet and left until the water has boiled for several minutes.
II.	The boiling water is poured into a teapot.
III.	Tea bags are added to the teapot and allowed to sit for several minutes before the bags are removed.
IV.	The hot tea is then poured into a container; sugar, lemon juice, and ice are added and mixed. The tea is placed in a refrigerator.

Multiple-choice question 1 (MC1) can only be answered by using information contained in the context. This question tests Unit 1–Concept 1: "explaining what is meant by the energy change of a system in terms of heating and cooling, thermal equilibrium, temperature change, phase change, forces between particles, particle movement and heat content." MC1 involves both a skill and STS component. It is expected that only students at the standard of excellence will be able to answer this question. The difficulty for this item is 19.3%.

1. In which step does the tea undergo an increase in kinetic energy?

A. I

B. II

• **C.** III

D. IV

Question MC2 requires the student to utilize information contained in the context. This question involves the same major concept, skill, and STS component as MC1 but it is expected that students at the acceptable standard will be able to answer this question. The difficulty for this item is 45.7%.

2. In the preparation of iced tea, where is there an increase in potential energy?

A. Step I only

B. Step II only

C. Steps II and III only

• **D.** Steps I and IV only

3. In which step is a temperature change of one of the components required to cause a change in potential energy of another component in the iced tea?

A. I

B. II

C. III

• **D.** IV

4. When a few drops of lemon juice is added to the tea, the colour of the solution changes. The main reason for the change in colour is that the

A. lemon juice dilutes the tea

• **B.** lemon juice is acidic and the tea acts as an acid-base indicator

C. tea is basic and the lemon juice acts as an acid-base indicator

D. hydronium (hydrogen ion) in the lemon juice reduces the tea

5. While making iced tea, a person's hand is burned from steam from the kettle. The burn is far more severe than a burn from the kettles' hot water would be because

A. a phase change is always exothermic

B. a phase change is always endothermic

C. condensing steam absorbs more energy from the surroundings than does an equivalent amount of hot water

• **D.** hot water releases less energy to the surroundings than does an equivalent amount of steam

Like the preceding two questions, this question requires the student to utilize information contained in the context. It also involves the same major concept, skill, and STS components. Like MC2, it is expected that students at the acceptable standard will answer correctly. The difficulty for this questions 64.3%.

Question MC4 is relevant to this context and tests a concept from a different unit, specifically Unit 3 Concept 3: "defining and describing indicators and explaining their colour changes in terms of an equilibrium shift." It is expected that students at the acceptable level will be able to answer the question successfully. The difficulty for this item is 61.3%

Question MC5 does not require the student to utilize specific information contained in the context but is relevant to the situation and is generalizable to other situations. It involves the Unit 1 Concept 1: "comparing phase, chemical, and nuclear changes in terms of magnitudes of energy involved" and has the same expectation as the previous questions. The difficulty for this question is 66.9%.

These questions demonstrate that at both the acceptable level and the standard of excellence there are a range of difficulties. These questions do not involve chemical concepts/knowledge unique to the new program of studies.

The next five questions are not in a scenario or context, but are selected to typify questions that can be expected to be found outside a scenario/context grouping. Several of these questions contain a common theme and could have been placed within a relevant scenario/context.

Question MC6 does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 1 Concept 1: “using standard heats of formation table to predict heat of reaction for a chemical change.” It is expected that students at the acceptable level will successfully answer this question. However, this question typifies the variety of methods of solving questions. The student at the acceptable standard may use long, time-consuming calculations to answer the question, whereas it is expected that a student at the standard of excellence could derive the correct answer without performing a single calculation. The difficulty of this item is 79.7%.

Question MC7 involves chemical concepts/knowledge unique to the new program of studies from the Unit 2 Concept 1 STS connection involving: “comparing oxidation-reduction reactions in living and non-living systems.” The expectation for this question is that students at the acceptable level will be successful. The difficulty of this item is 82.3%.

Question MC8 involves chemical concepts/ knowledge unique to the new program of studies from Unit 1 Concept 1: “comparing cellular respiration represented by the simple equation: $6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$ to the combustion of fuels.” The expectation for this question is that students at the acceptable level will be successful. The difficulty of this item is 68.0%.

6. The energy stored in hydrocarbons can be released by combustion. When one mole of each of the following fuels is burned to form gaseous products, which fuel releases the greatest amount of energy?

A. butane
B. ethane
• **C.** pentane
D. propane

7. Which source of energy contributes to the greenhouse effect?

A. solar cells
B. nuclear reactors
C. hydroelectric power plants
• **D.** coal-fired power plants

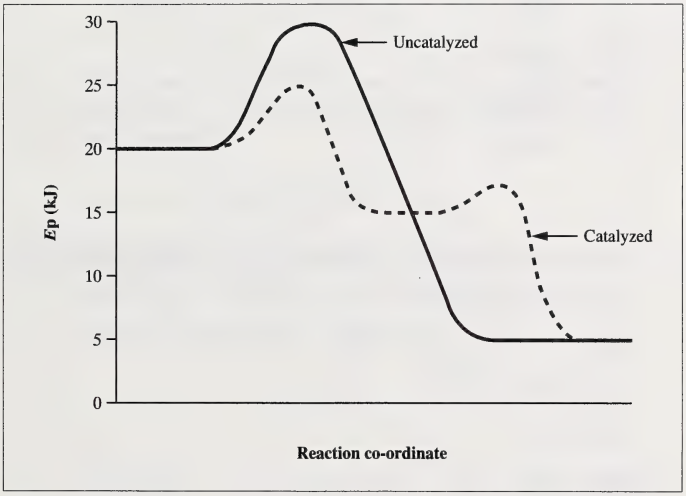
8. Select the **false** statement.

A. Photosynthesis is an example of light energy converted into chemical energy.
B. Combustion of hydrocarbons is an example of chemical energy converted into heat and light energy.
• **C.** The glow of a firefly is an example of light energy converted into chemical energy.
D. The operation of a dry cell battery is an example of chemical energy converted into electrical energy.

9. Plants remove carbon dioxide from our atmosphere during photosynthesis. The balanced chemical equation for the reaction is

• **A.** $6\,CO_{2(g)} + 6\,H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6\,O_{2(g)}$
B. $6\,CO_{2(g)} + 6\,H_{2(g)} \rightarrow C_6H_{12}O_{6(s)} + 3\,O_{2(g)}$
C. $6\,CO_{2(g)} + 6\,H_2O_{(l)} \rightarrow C_6H_{12}O_{2(s)} + 8\,O_{2(g)}$
D. $12\,CO_{2(g)} + 11\,H_2O_{(l)} \rightarrow C_{12}H_{22}O_{11(s)} + 12\,O_{2(g)}$

Use the following graph to answer the next question.



10. The ΔE_p for the forward catalyzed reaction would be

A. –5 kJ
B. –10 kJ
• **C.** –15 kJ
D. –20 kJ

Question MC9 involves chemical concepts/knowledge unique to the new program of studies from Unit 1 Concept 1: “explaining how energy stored as potential energy in the chemical bonds of fossil fuels originate in the sun and is converted by the process of photosynthesis in living plants represented simply as : $6CO_{2(g)} + 6H_2O_{(l)} \rightarrow C_6H_{12}O_{6(s)} + 6O_{2(g)}$.” The expectation for this question is that students at the acceptable level will be successful. The difficulty of this item is 68.0%.

This question involves chemical concepts/knowledge unique to the new program of studies from Unit 1 Concept 1: “explaining that catalysts provide an alternative pathway for chemical changes without affecting the net amount of energy produced or absorbed.” The expectation for this question is that students at the acceptable level will be successful. The difficulty of this item is 71.2%.

The shaded text indicates a new series of questions that are based upon a scenario/context/STS. In this case, there is a series of questions based upon the chemistry of a breathalyzer.

Question MC11 does not involve chemical concepts/knowledge unique to the new program of studies. It is expected that students at the acceptable level will successfully answer this question. The difficulty of this item is 44.0%.

Question MC12 involves chemical concepts/knowledge unique to the new program of studies from Unit 2 Concept 1: "writing and balancing equations for oxidation-reduction reactions." The expectation for this question is that students at the standard of excellence will be successful since this questions requires the student to create their own half-reactions. The difficulty of this item is 35.9%.

Question MC13 involves chemical concepts/knowledge unique to the new program of studies from Unit 3 Concept 1: "writing and interpreting chemical reaction equations for chemical systems at equilibrium." The expectation for this question is that students at acceptable standard will be successful. The difficulty of this item is 57.4%.

Note: Questions 11 and 13 would not appear together on an examination since question 13 answers question 11.

The breathalyzer test is used to determine blood alcohol content. The alcohol vapour in breath is analyzed by its reaction with acidified potassium dichromate represented by the unbalanced equation:

$$Cr_2O_7^{2-}{}_{(aq)} + C_2H_5OH_{(g)} + H^+_{(aq)} \rightarrow Cr^{3+}_{(aq)} + CH_3COOH_{(aq)} + H_2O_{(l)}$$

The extent of reaction is proportional to the amount of alcohol in the breath sample and to the blood alcohol content.

11. If a sample containing alcohol was tested, one would expect the colour of the test sample to become more

A. blue
• **B.** green
C. orange
D. yellow

12. When the equation is balanced, using whole numbers, the coefficient of $H^+_{(aq)}$ is

A. 8
B. 12
C. 14
• **D.** 16

13. The amount of alcohol in the breath sample is most likely determined by the

• **A.** colour change of the solution
B. change in density of the solution
C. voltage produced by the reaction
D. conductivity of the solution

14. Which of the following empirical characteristics could **not** be used to show that equilibrium has been attained in a system?

A. colour constant

B. pressure constant

• **C.** mass constant

D. temperature constant

Use the following information to answer question 15.

$$PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)} \quad K_{eq} = 0.18$$

15. If a 1.00 L container with 1.00 mol of $PCl_{3(g)}$, 1.00 mol $Cl_{2(g)}$ and 1.00 mol $PCl_{5(g)}$ is allowed to reach equilibrium, the flask would contain

• **A.** more $PCl_{3(g)}$ and $Cl_{2(g)}$ than $PCl_{5(g)}$

B. more $PCl_{3(g)}$ and $PCl_{5(g)}$ than $Cl_{2(g)}$

C. more $PCl_{5(g)}$ than $PCl_{3(g)}$ and $Cl_{2(g)}$

D. more $Cl_{2(g)}$ and $PCl_{5(g)}$ than $PCl_{3(g)}$

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16. For a 0.025 mol/L solution of $HCN_{(aq)}$, which condition is **true**?

• **A.** $[HCN_{(aq)}] > [H_3O^+_{(aq)}]$

B. $[OH^-_{(aq)}] > [H_3O^+_{(aq)}]$

C. $[CN^-_{(aq)}] > [H_3O^+_{(aq)}]$

D. $[HCN_{(aq)}] > [CN^-_{(aq)}]$

Question MC14 involves chemical concepts/knowledge unique to the new program of studies from Unit 3 Concept 1: “stating the criteria that apply to a system at equilibrium; e.g., closed system, constancy of properties, evidence of reversibility, equal rates of forward and reverse reaction.” The expectation for this question is that students at acceptable standard will be successful. The difficulty of this item is 68.1%.

Question MC15 involves chemical concepts/knowledge unique to the new program of studies from Unit 3 Concept 1: “predicting whether or not reactants or products are favoured in a reversible reaction, on the basis of the magnitude of the equilibrium constant.” The expectation for this question is that students at acceptable standard will be successful. It is not expected that students undertake to solve for the actual value of the equilibrium concentrations, although that approach to solving the question is mathematically challenging and valid. The difficulty of this item is 41.9%.

Question MC16 involves chemical concepts/knowledge unique to the new program of studies from Unit 3 Concept 1: “predicting whether or not reactants or products are favoured in a reversible reaction, on the basis of the magnitude of the equilibrium constant.” The expectation for this question is that students at the acceptable standard will be successful. It is not expected that students undertake to solve for the actual value of the equilibrium concentrations, although that approach to solving the question is mathematically challenging and valid. The difficulty of this item is 40.3%.

The next item in this test is a numerical response question. Note that the question is numbered 1, in inverse print, even though this is the seventeenth question on the test.

Students should expect question formats to vary throughout the entire test. This question involves several chemical concepts/knowledge from the new program of studies. Specifically, Unit 3 Concept 3: "identifying conjugate pairs of Brønsted-Lowry acids and bases in chemical reaction equations" and Unit 3 Concept 1: "predicting whether or not reactants or products are favoured in a reversible reaction, on the basis of the magnitude of the equilibrium constant." The expectation for this question is that students at the standard of excellence will be successful since this question requires students to integrate their knowledge. The difficulty of this item is 22.2%.

This item is also a numerical response question. Note that the question is numbered 2, in inverse print, even though it is the eighteenth question on the test. This question does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3: "defining and describing indicators and explaining their colour changes in terms of equilibrium shifts" and the skill "using indicators to determine the approximate pH of an acid or base solution." The expectation for this question is that students at the acceptable standard will be successful. The difficulty for this item is 78.3%.

The nineteenth question is a multiple-choice question and is numbered 17 since it is the seventeenth multiple-choice question. It involves chemical concepts/knowledge unique to the new program of studies from Unit 3 Concept 2: "performing calculations to determine any of pH, pOH, $[H_3O^+_{(aq)}]$, $[OH^-_{(aq)}]$, K_a, or K_b from the masses of solute, volumes, and concentrations of solutions." The expectation for this question is that students at the standard of excellence will be successful. The difficulty for this item is 22.7%.

Numerical Response

1. Use the equation:

$$\underset{(1)}{H_2PO_4{}^-{}_{(aq)}} + \underset{(2)}{HCO_3{}^-{}_{(aq)}} \rightleftharpoons \underset{(3)}{H_2CO_3{}_{(aq)}} + \underset{(4)}{HPO_4{}^{2-}{}_{(aq)}}$$

In the reaction that is favoured, the numbers that correspond to the acid, conjugate base, base, conjugate acid, respectively, are ______, ______, ______, and ______.

(Answer — 3241)

2. The following data were collected when four different solutions were tested with different indicators.

Solution	Indicator	Colour
1	indigo carmine	yellow
2	methyl red	orange
3	thymol blue	green
4	orange IV	red

Using this data, the four solutions arranged in order of decreasing pH are ______________.

(Answer — 1324)

17. A 0.0250 mol/L sample of a monoprotic acid is tested with a pH meter and determined to have a pH = 2.75. The calculated K_a for this acid is

• **A.** 1.36×10^{-4}
B. 1.26×10^{-4}
C. 3.16×10^{-6}
D. 7.35×10^{3}

18. If aqueous solutions of $NaHCO_{3(aq)}$, $NaHSO_{4(aq)}$, $NaHS_{(aq)}$, and $NaHSO_{3(aq)}$ were mixed together, the most probable Brønsted-Lowry acid base reaction would be

• **A.** $HSO_4{}^-{}_{(aq)} + HS^-{}_{(aq)} \rightleftharpoons H_2S_{(aq)} + SO_4{}^{2-}{}_{(aq)}$

B. $HCO_3{}^-{}_{(aq)} + HSO_3{}^-{}_{(aq)} \rightleftharpoons H_2CO_{3(aq)} + SO_3{}^{2-}{}_{(aq)}$

C. $HSO_4{}^-{}_{(aq)} + HSO_3{}^-{}_{(aq)} \rightleftharpoons H_2SO_{3(aq)} + SO_4{}^{2-}{}_{(aq)}$

D. $HCO_3{}^-{}_{(aq)} + HS^-{}_{(aq)} \rightleftharpoons H_2S_{(aq)} + CO_3{}^{2-}{}_{(aq)}$

Question MC18 does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3; “writing and interpreting chemical reaction equations illustrating the Brønsted-Lowry definition of acids and bases and neutralization” and the skill “predicting the most likely acid-base reaction, using tables of relative acid-base strength.” The expectation for this question is that students at acceptable standard will be successful. The difficulty for this item is 73.0%.

19. Which of the following would **not** be a buffer system?

A. A weak acid and a salt of its conjugate base

• **B.** A weak acid and a strong acid

C. A weak base and its conjugate acid

D. A weak base and a weak acid

This question does involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3: “explaining how buffers maintain a relatively constant pH when small amounts of acid, base, or solvent are added to an aqueous system.” The expectation for this question is that students at acceptable standard will be successful. The difficulty for this item is 72.5%.

20. An acetic acid-sodium acetate buffer solution is prepared. When small amounts of $HCl_{(aq)}$ are added, the solution is able to maintain a near constant pH because

• **A.** the acetate ion in the buffer will react with almost all of the $H_3O^+{}_{(aq)}$ from the $HCl_{(aq)}$

B. $HCl_{(aq)}$ is a weak acid and will not interfere with the pH of the buffer

C. the $H_3O^+{}_{(aq)}$ from the $HCl_{(aq)}$ will react with the acetic acid molecules causing no change in pH

D. the $OH^-{}_{(aq)}$ in the aqueous buffer will neutralize the $H_3O^+{}_{(aq)}$ from the $HCl_{(aq)}$

This question is another example of Unit 3 Concept 3: “explaining how buffers maintain a relatively constant pH when small amounts of acid, base, or solvent are added to an aqueous system.” The expectation for this question is that students at the acceptable level will be successful. The difficulty for this item is 55.5%.

The shaded text indicates that there is another series of questions that are based upon the scenario/context/STS introduction. In this case, there is a series of questions based upon the chemistry involved an industrial lab analysis.

This question does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3: "performing calculations related to quantitative reactions between acids and bases, including excess reagents in strong acid-strong base combinations" and the skill: "performing a titration experiment and related calculations to determine the concentration of an acid or base solution." The expectation for this question is that students at acceptable standard will be successful. The difficulty for this item is 53.5%.

Question MC22 does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3: "differentiating between indicator end point and equivalence point." The expectation for this question is that students at acceptable standard will be successful . The difficulty for this item is 37.5%.

Question MC23 does not involve chemical concepts/knowledge unique to the new program of studies and addresses Unit 3 Concept 3: "performing calculations related to quantitative reactions between acids and bases, including excess reagents in strong acid-strong base combinations" and the skill: "using a pH meter and laboratory glassware related to titrations." The expectation for this question is that students at standard of excellence will be successful. The difficulty for this item is 27.7%.

In the analysis of a chemical spill of hydrochloric acid, Phill, an environmental chemist with Hoky Services, titrated a 10.0 mL sample of $HCl_{(aq)}$ to a green bromocresol green end-point with 0.023 mol/L $NaOH_{(aq)}$. The volume required for four successive titrations was 10.4 mL, 16.5 mL, 16.6 mL, and 16.4 mL.

21. The value for the concentration of the sample is

A. 0.15 mol/L
• **B.** 0.038 mol/L
C. 0.034 mol/L
D. 0.014 mol/L

22. One should conclude that in the titration

A. the equivalence point had been reached
B. the indicator endpoint occurred just after the equivalence point
C. the actual concentration of Phill's sample is much lower than the experimental value
• **D.** an inappropriate end-point was selected for the titration

23. If Phill had used a pH meter instead of an indicator and took pH readings for each consecutive 1.0 mL addition of $NaOH_{(aq)}$ until excess base was present in the flask. The next step Phill must perform to find the concentration of the acid is to

A. calculate the number of moles of base
• **B.** draw the titration curve
C. calculate the number of moles of acid
D. find the equivalence point

Use the following information to answer the next question.

> As the human population and the demands of society have expanded, humans have developed a variety of energy sources to meet the needs of society and industry. All of these energy technologies effect the environment by either altering the geography or releasing substances.

Written Response

1. Describe the composition of a substance that is currently being added to our environment. Explain the risks and benefits associated with this substance. Present an argument for how you think we should deal with this substance.

The last question on this test is a written response. Note that the number is framed and preceeded by a notation that the question is a written response. As was true for the numerical response, the question is numbered 1 even though it is the twenty-sixth question. This question is an example of an open-response question and is of the type that would be scored holistically by two markers. It is impossible to identify a curricular reference to this question since the student will determine the nature of the response. The response could come from a redox, acid–base, or energetics perspective. Answers to this question that typify each of the levels follow beginning on page 24.

Scoring Criteria for the Written-Response Question

Scoring Guide for Knowledge: Chemistry

Level	Criteria
4 Standard of Excellence	The response presented addresses all the key components of the question correctly.
3	The response presented addresses all the key components of the question. However, there are more correct arguments/procedures/algorithms than incorrect or unstated arguments/procedures/algorithms.
2 Acceptable Standard	The response presented addresses all the key components of the question. However, there are more incorrect or unstated arguments/procedures/algorithms than correct. *or* The response presented is valid but incomplete and therefore cannot generate a complete response. Of all possible arguments/procedures/algorithms presented for their response, more are correct than incorrect or unstated.
1	The response presented is valid but incomplete and therefore cannot generate a complete response. Of all the possible arguments/procedures/algorithms presented for their response, more are incorrect or unstated than correct.
0	The response presented is inappropriate or incorrect for the problem.
NR	No response given.

Sample Answers

The sample responses that follow were graded by several classroom teachers using the preceeding holistic scoring guide for knowledge.

The next three sample responses meet the criteria of a 4.

Sample 1

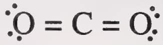
CO_2 is presently being added to our environment through the combustion of hydrocarbons
$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$
CO_2 is composed of a carbon atom and 2 oxygen atoms.

This CO_2 poses a risk to the environment as it accumulates it the atompshere. CO_2 allows radiation from the sun to pass through the atmosphere, but the CO_2 prevents the heat from escaping back into space. Very little radiation is permitted to escape and this causes global warming. CO_2 accumulation in the atmosphere is also known as the greenhouse effect as the CO_2 acts like a greenhouse in heating the earth to abnormally high temperatures. If this continues the average temperature of the earth will rise, causing melting of the polar ice caps. This in turn will cause the sea level to rise which will rsult in disasterous floodings of many important costal cities, eg. Miami, Florida.

The benefit of CO_2 relates to plants. Plants use CO_2 during photosynthesis, and produce O_2 at the end. Without CO_2 we would not have photosynthesis and therefore O_2 . By planting more trees and reducing the burning of hydrocarbons (by using nuclear power perhaps) the high levels of CO_2 will be diminished. CO_2 is not a harmful chemical unless it is found in excess. In excess it causes global warming.

Sample 2

One substance currently being added to our environment is carbon dioxide, or $CO_{2(g)}$. This substance is a covalently-bonded compound composed of carbon and oxygen in the following manner:



$O = C = O$

Carbon dioxide is released when hydrocarbons, such as ethane, propane, and other fuels, are burned:

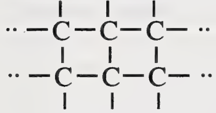
$$2C_2H_{6(g)} + 7O_{2(g)} \rightarrow 4CO_{2(g)} + 6H_2O_{(l)}$$

$CO_{2(g)}$ is a somwhat risky substance to be released into our environemnt, because when it is added to our atmosphere it, along with other gases, traps heat from the sun which would normally escape, thus causing a gradual increase in the earth's temperature. If the temperature of the earth increases too much, glaciers at the poles of the earth will begin to melt thereby causing flooding, and the climate in several areas of the world could change drastically. Thus both outcomes would effect animal (including human) and vegetable populations throughout the world. However, $CO_{2(g)}$ is useful to plants for use in their photosynthetic processes, and is thus useful to human and animal populations which depend on vegetation for food and raw materials.

Thus, since $CO_{2(g)}$ is useful to plants, excess $CO_{2(g)}$ could be used up by planting more trees in particular, which would also be of food/raw material benefit to humans and animals alike.

Sample 3

To deal with changing realities, chemists have discovered new substances. Many of these are synthetic polymers: e.g. polyethylene. It consists of repeated subunits of $-\overset{|}{\underset{|}{C}}-$ groups with more groups bonded to it, creating an ultralarge molecule like this:



$-\overset{|}{\underset{|}{C}}-$ Polymers like polyethylene are very useful. We use polyethylene (or polystyrene, or others) in everything from fast-food containers to insulation. More complicated polymers are used in the construction of new automobiles and space vehicles, as the strength of the new ‘plastics’ edges higher and higher. As polymers are both easy and inexpensive to make, innovative industries are finding new ways to make use of polyethylene in the strangest places. For example, some biomedical companies use different types of decay-resistant polymers in artificial implants. Unfortunately, there are many risks to the environment associated with the use of synthetic polymers. The same strength and decay-resistance which makes them so useful make them very difficult to remove. Most polymers are not biodegradable. As our society uses more and more of them, a slow but steady growth in polymer waste is inevitable. The dilemma remains how to protect the environment from polymer accumulation without denying us the use of such useful chemicals. Perhaps the best solution is a compromise. We should limit the use of polyethylene (for example) in products where other, more biodegrable substances exist. Fast-food restaurants like McDonald’s should be discouraged from using polystyrene when paper would work as well. Moreover, the recycling of polymers should become more common place: it is relatively simple to melt and reform polymers compared to many other substances. However, we should not deny ourselves so great a source of potential development as synthetic plastic. Polymers are here to stay, and with a moderate policy in place, we can make the most of them.

The next four samples were judged to meet the criteria of a 3.

Sample 1

One substance that is being pumped into our environment is lead. In various forms we are adding this lethal substance. It is present in many things such as lead nitrate, lead sulfide and in its monoatomic element. Lead is found in many things from batteries to X-ray shields to house paint to crayons. Lead is beneficial while it is in use as X-ray shielding or batteries, but when we discard them they can be a serious health hazard. In house paints and crayons they can be ingested by children or seep into our water supplies where it can be lethal. We also put lead, in its compounds, into the environment and it tends to be destructive. If we were all just a little bit more conscious of the problem, we could find better ways of handling this toxic waste. Amen.

Sample 2

Carbon dioxide is a molecular substance made up of carbon and oxygen. It is produced in the combustion of fossil fuels. Humans produce carbon dioxide through cellular respiration and organisms which photosynthesize for nutrients use carbon dioxide. Carbon dioxide is therefore an important substance in our world until the past few centuries, the presence of carbon dioxide has not been a problem. With the development of machinery which burns fossil fuels, and the amount of use of this machinery, people have created an excess of carbon dioxide in the atmosphere. This excess carbon dioxide contributes to the greenhouse effect and to the depletion of the ozone layer, a layer of gas in the earth's atmosphere which prevents the penetration of some of the sun's harmful rays.

The best method of dealing with carbon dioxide would be to cut down on the amount of fossil fuels which are burnt and finding alternative methods of providing energy. It would also be beneficial to reduce the depletion of the rainforest as the plants there help to use up the carbon dioxide. It would be very helpful to plant more trees and cut back ont he logging of old growth forests.

Sample 3

$SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$

Sulfur dioxide is currently being added to our environment everyday by our society. It is mainly being released into the environment by industries. Sulfur dioxide is extrapilated intot he air and then mixed with water in the atmosphere. When it mixes with the water it becomes $H_2SO_{4(aq)}$ which is an acid. The $H_2SO_{4(aq)}$ is what is harmful tot he environment. This acid contaminated our earths natural waters and thus the elimination of many important species that are part of our ecosystem and food chain.

We do need our industries though to keep up with human needs, the solution we need is to find a way to dispose of the sulfur dioxide before it has a chance to become harmful. As an example, make factories clean out their smoke stacks and rid them of SO_2 or use alternative methods. Rules and regulations need to be set for industries to follow and amounts of polution from the industries should be monitored. Stiff fines should be implemented for industries not following regulations.

Sample 4

Carbon dioxide or CO_2 is one of the most well used byproduct today. We get $CO_{2(g)}$ usually as a form of burning substances. it is also given off as a byproduct of breathing. People exhale $CO_{2(g)}$ into the atmosphere. Carbon dioxide is said be contributing to the greenhouse effect. The greenhouse effect is the general warming of the atmosphere when the excess $CO_{2(g)}$ is not absorbed it remains an starts to warm up the earths air. Eventually they say though that it could make the whole world into a big deseret. Although we couldn't live without it. Trees transform CO_2 into O_2 in which people need to breath. Therefore if we didn't breathe CO_2 out no more O_2 could be made. We use this gas so widely that it might be tuff to stop we use it to carbonate drinks and to use as a sheilding gas when welding. It will be hard to contain, but less burning in the atmosphere would help.

These six responses typify the criteria of a 2.

Sample 1

In todays society, effiency is a basic want among our population. Therefore we need things that are fast and non-time comsuming. Cars are a good example of this. If you have a car, you don't have to walk, wait for the bus or a taxi and they can go as fast as you want them to. One bad thing about everybody having a car is that it creats smog (although it is not just the cars; factories and other things are to be involved in it.) One poisonous gas that a car produces is $CO_{(g)}$. Carbon monoxide gas is a deadly poison to be inhaled. Partially because it is poisonous; if you inhale it it will stick to elements (components) of your blood (the oxygen). then when all of the oxygenated cells of the blood are filled, you can poison yourself and fall to sleep and never wake up. Some people who want to commit suicide will do it this way.

Car exhaust leads to smog which in small areas it is not too concentrated but when a big area (i.e. New York) it is very concentrated. Big clouds of smoke and other gases hover in the air around the big buildings. Even Toronto is suffering from smog. The only way that we can cut down on this is if we all try and help. If it is a nice summer day, leave the keys at home and walk. Some other suggestions are take the bus, subway, taxi or car pool. Ride a bike, the exercise may do you good who knows?

Sample 2

$CO_{2(g)}$ - 1 carbon + 2 oxygen molecules

Too much $CO_{2(g)}$ is being added into the atmosphere. It is causing global warming. The light rays from the sun can reach the earth, but they are not being deflected back out because of the $CO_{2(g)}$ in the atmosphere. It will eventually cause global cooling because the rays of the sun won't be able to reach the earth.

People should cut down on the amount of air pollution causing this by talking buses, walking or riding a bike. Factories should also cut down on the amount of $CO_{2(g)}$ they release. Governments should make laws to regulate the amounts of air pollution given of by factories.

Sample 3

SO_2 . Sulfur Dioxide

SO_2 ,Sulfur Dioxide is released into the air from some factories and distributes itself throughout the environment, the release of this chemical is dangerous because its one of the factors which contribut to acid rain. The way this happens is the SO_2 gets binded to form H_2SO_4 and this has damaging effects on forestry and wild life. I think we should make a law that this chemical may need be allowed to be produced and released into our environment, there are no benefits that could be great enough to risk our environment for.

Sample 4

My favorite compound is sulfur dioxide. This is composed of one sulfur atome and two oxygen atoms. i.e. SO_2. This chemical is added to our environment through industrial processes and car exhaust. The benefits of SO_2 are exactly these processes such as metal refining and car driving with produce SO_2. It's drawback is that when released into the atmosphere, it combines with water to make acid rain. This acid rain falls in lakes and can kill the life there by lowering its pH. Rain also can cause damage to buildings by reacting with the stone on the exterior walls. This is a mounting problem which must be dealt with.

Sample 5

With the population rising dramatically our cities are becoming bigger. With this, the question of transportation to where you have to go becomes a problem. More and more people are buying cars, may be 2 or even 3 per household, to get to work, school and the grocery store. All of these cars are causing polution; they emit carbon monoxide ($CO_{(g)}$) into the environment, which can cause acid rain and smog. Carbon monoxide causes not only damage to the earth but to the people as well by consumption of the contaminated water, and breathing in the thick black air which can both cause genetic problems and diseases in people and unborn children.

This problem could be solved by finding alternatives to the fuel used to run the cars so that CO will not be emitted. People could also car pool to work and school to lesen the amount produced of if where you are going is close by, ride a bike or walk.

Sample 6

Detergents are substances which are currently being added to our environment. These are organic compounds of varying structures and compositions which are harmful to the ecosystem. These "man-made" substances are useful to humans in cleaning and washing purposes. Over soap, detergents have a multitude of benefits. However, detergents are not biodegradable and therefore stay in the ecosystem for a very long time. In essence detergents "just keep on cleaning". In other words they destroy the environment, killing many microorganisms and promoting the growth of others. This imbalance is noticeable when lakes or ponds become "murky" or "slimy". This imbalance, caused mainly by detergent, pollutants, seriously damages the environment. Human societies cannot just stop cleaning so this problem could be difficult to remedie. By using soap, which is biodegradable, or combinations of soap and detergents it may be possible to reduce or eliminate this problem. Detergents may clean people, but they dirty the planet.

These three responses meet the criteria of a 1.

Sample 1

Carbon monoxide $CO_{2(g)}$ is a dangerous gas that is being released into the atmosphere by vehicles, by factory work, etc. The carbon monoxide instantly attacks the ozone thus depleting the amount of protection we received from UV rays. UV rays can be very deadly, creating many skin cancers. Society should try to understand the damage we are doing, we need to cut down on vehicle use saving it for long distance travel. The factory situation may be harded to deal with..."?" science will jsut have to put more effort into trying the neutralize our present situation. If we can create the mess God knows we can find a solution to our problem! Vehicle's do present a convience to our society, but we have abused that convience.

Sample 2

Comp. $C_{(g)} + O_{2(g)} \rightarrow CO_{2(g)}$

risks – Damage to ozone layler (temp of Globe in danage)
– It helps to produce acid rain (damge to lakes and forests, and enviroment in whole)

Due to its many damages to the enviroment, this substance must be tried to be kept to its minimum in its production.

Sample 3

Carbon monoxide is being released from our cars at a huge rate. Gasoline is burned to produce this harmful gas. Carbon monoxide not only is a good fuel for cars, but is also a killer towards humans because it is poisonous and towards the enviroment, slowly but constantly destroying the ozone layer. If we could find some way of burning hydrogen safely, the only product would be water, and how harmful if water? Until then, I guess we car pool, use the transit system, ride a bike, or even walk. Reducing the amount of cars will also help.

The last three responses meet the criteria of a 0.

Sample 1

The composition of a substance that is currently being added to our environment is Nitrogen. The risks of adding this substance to our environment is it helps destroy our lakes, rivers and ponds, by rain and irrigation run-off from farmers fields. The nitrogen also kills parts of the food chain because the producers of the food chain absorb it and as it goes up the chain it gets more concentrated and can kill of certian parts of an ecosystem.

The Benifits for using nitrogen helps farmers grwo better crops and make more money of their yeild. The nitrogen also puts back nutrients intot he soil for other plants to grow.

To deal with this problem I think people should grow plants that put nitrogen back in the soil naturaly for example Alphalpha and clover and only use natural fertalizers, because in the long run it could save our fresh water, wild life and plants.

Sample 2

The corrosion of huge boats that carry oil are great hazards to the environment. Because the iron corrodes on the oil tanks, the oil spills into the ocean.

$$\begin{array}{r}
\mathrm{Fe}_{(s)} \rightarrow 2\mathrm{e}^- + \mathrm{Fe}^{2+}_{(aq)} \\
2\mathrm{H_2O}_{(l)} + 2\mathrm{e}^- \rightarrow \mathrm{H}_{2(g)} + 2\mathrm{OH}^- \\
\hline
\mathrm{Fe}_{(s)} + 2\mathrm{H_2O}_{(l)} \rightarrow \mathrm{Fe}^{2+}_{(aq)} + 2\mathrm{OH}^-_{(aq)}
\end{array}$$

This process releases hydrogen gas as well, and the oil is damaging to the environment.

By galvanizing it with zinc, the iron will be protected by the zinc, which will corrode inplace of the iron. However, the zinc must be replaced periodically due to corrosion.

$$\begin{array}{r}
\mathrm{Zn}_{(s)} \rightarrow 2\mathrm{e}^- + \mathrm{Zn}^{2+} \\
\mathrm{H_2O}_{(l)} + 2\mathrm{e}^- \rightarrow \mathrm{H}_{2(g)} + 2\mathrm{OH}^-_{(aq)} \\
\hline
\mathrm{Zn}_{(s)} + 2\mathrm{H_2O}_{(l)} \rightarrow \mathrm{H}_{2(g)} + 2\mathrm{OH}^-
\end{array}$$

Sample 3

A substance being added to our environment includes $H^+_{(aq)}$. This substance is of benefit for the reason that when it comes in contact with (oxygen gas) $O_{2(g)}$ it makes (water) $H_2O_{(l)}$. $O_{2(g)} + 4H^+_{(aq)} + 4e^- \rightarrow 2H_2O_{(l)}$. (Taken from Chemistry Data Booklet Alberta Education Pg.11) According to the modified theory, this substance is also a potential hazard for the reason that when $H^+_{(aq)}$ reacts with water, it produces $H_3O^+_{(aq)}$ which has an acidic nature and produces 'acid rain'. Also according to page 11 of the Chemistry Data Booklet from Alberta Education, when $H^+_{(aq)}$ reacts with water ($H_2O_{(l)}$), it can also produce $H_2O_{2(l)}$ (hydrogen peroxide). Not only does the hydrogen peroxide ($H_2O_{2(l)}$) destroy bacteria that is necessary in decomposition and stability in the environment, the acid rain produced, kills plants, vegetation as well as destroying water life which in turn effects the equilibrium in nature. It is obvious the risk of this substance entering our environment far outweights the benifits and we need to strictly regulate, if not eliminate the emmission of $H^+_{(aq)}$ because of the contamination and degeneration that it causes.

Appendix A

Calculator Policy

POLICY: USE OF CALCULATORS ON ALBERTA EDUCATION DIPLOMA EXAMINATIONS

Background

The knowledge, skills, and attitudes relevant to technology and its uses are being incorporated into courses and progra of study wherever appropriate. Students are expected to learn the advantages and limitations of technologi developments and their impact upon society. The ability to use technology helps students understand and appreciate process of technological change, gives added depth to programs, and provides the basis for the development of skills a understanding. These expectations are reflected in the diploma examinations. Since the data provided for writing diplo examinations in mathematics and the sciences do not include information such as logarithms and trigonometric functio students will need to use scientific calculators for these exams.

Definition

This policy considers a scientific calculator to be a hand-held device designed primarily for mathematical computations. Included in this definition are those scientific calculators having graphing capabilities, built-in formulas, mathematical functions, or other programmable features.

Policy

To ensure compatibility with provincial *Programs of Study* and equity and fairness for all students, Alberta Educat expects students to use scientific calculators, as defined above, when they are writing diploma examinations mathematics and the sciences. Examinations are constructed to ensure that the use of particular models of calculat neither advantages nor disadvantages individual students.

Procedures

1. Teachers must, at the beginning of a course, advise students of the types of calculators that they may use when writ diploma examinations in mathematics and the sciences. Teachers must also advise students of the types of informat that can be stored in calculators that are brought into diploma examinations.

2. Students must clear calculators that are brought into diploma examinations of all information previously stored except for
   a. programs used for computing values of the formulas that are provided on the diploma examination tear- pages or in a separate data booklet for the subject being written,
   b. programs used for Quadratic Relations as found in the Mathematics 30/33 Interim Teacher Resource Manu

3. Students must not bring external devices to support calculators into the exam. Such devices include manuals, prin or electronic cards, printers, memory expansion chips or cards, external keyboards, or any annotations outlin operational procedures for scientific calculators.

4. In preparation for calculator failure, students may bring extra calculators and batteries into the exam room.

5. During exams, supervising teachers must ensure that
   a. all calculators operate in silent mode,
   b. students do not share calculators or information contained within them,
   c. calculator cases are stored on the floor throughout the exam, and
   d. all examination rules are followed.

6. If you have any questions or comments about the implementation of this policy, please contact the Math/Science U Student Evaluation Branch, at 403-427-0010 or FAX 403-422-4200.

Revised 19 September 94

Appendix B

Examination Rules

GRADE 12 DIPLOMA EXAMINATIONS

1. **Admittance to the Examination Room**
   Students must not enter or leave the examination room without the consent of the supervising teacher.

2. **Student Identification**
   Students must present identification that includes their signature and photograph. One of the following documents is acceptable: driver's licence, passport, or student identification card. Students must not write an examination under a false identity or knowingly provide false information on an application form.

3. **Identification on Examinations**
   Students must not write their names or the name of their school anywhere in or on the examination booklet other than on the back cover.

4. **Time**
   Students must write an examination during the specified time and may not hand in a paper until at least one hour of the examination time has elapsed. Students who arrive more than one hour after an examination has started will not be allowed to write the examination. Students who arrive late but within the first hour of an examination sitting may be allowed to write only at the discretion of the supervising teacher.

5. **Discussion**
   Students must not discuss the examination with the supervising teacher unless the examination booklet is incomplete or illegible. Students must not talk, whisper, or exchange signs with one another.

6. **Answer Sheets**
   Students must use an HB pencil to record their answers on the machine-scorable answer sheets.

7. **Written Responses**
   All work for the written-response sections of the diploma examinations must be done in the examination booklet. Students are expected to write their revised work in blue or black ink for English 30, English 33, Français 30, and Social Studies 30.

8. **Material Exchanges**
   Students must not copy from other students or exchange material. Notes in any form—including those on papers, in books, or stored in electronic devices—must not be brought into the examination room. Calculator programs designed to perform mathematical computations or those designed to assist students in graphing are not classified as notes (see *Calculator Policy*).

9. **Materials Allowed**
   English 30, English 33: Students may use a dictionary and a thesaurus for Part A only. Electronic devices are not allowed for either part.
   Français 30: Students may use a dictionary, a thesaurus, and a book of verb forms for Partie A only. Electronic devices are not allowed for either part.
   Social Studies 30: Students may not use electronic devices.
   Biology 30, Mathematics 30, Physics 30: Tear-out data pages are provided in the examination booklet. Students need to use scientific calculators (see *Calculator Policy*) but must not share them.
   Chemistry 30, Science 30 (Pilot): A separate data booklet is provided for each of these examinations. Students need to use scientific calculators (see *Calculator Policy*) but must not share them.

   Students are expected to provide their own writing materials, including pens and HB pencils, calculators, or other necessary instruments. Tear-out pages for rough work are provided in each biology, chemistry, mathematics, physics and science (pilot) examination booklet.

10. **Translation Dictionaries**
    Students are not allowed to use translation dictionaries in any subject. Exchange students must satisfy the same requirements as other students.

Students First!
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Appendix C

Guidelines for Significant Digits, Manipulation of Data, and Rounding in the Mathematics and Sciences Diploma Examinations

Significant Digits

1. For all non-logarithmic values, regardless of decimal position, any of the digits 1 to 9 is a significant digit; 0 may be significant. For example:

   123 0.123 0.00230 2.30×10^3
   all have 3 significant digits

2. Leading zeros are not significant. For example:

   0.12 and 0.012 each have two significant digits

3. Trailing zeros to the right of the decimal are significant. For example:

   0.123 00 and 20.000 each have five significant digits

4. Zeros to the right of a whole number are considered to be ambiguous. **The Student Evaluation Branch considers all trailing zeros to be significant**. For example:

   200 has three significant digits

5. For logarithmic values, such as pH, any digit to the left of the decimal is **not** significant. For example:

   a pH of 1.23 has two significant digits
   a pH of 7 has no significant digits

Manipulation of Data

1. When adding or subtracting measured quantities, the calculated answer should be rounded to the same degree of precision as that of the least precise number used in the computation **if this is the only operation**. For example:

12.3	(least precise)
0.12	
12.34	
24.76	

   The answer should be rounded to 24.8.

2. When multiplying or dividing measured quantities, the calculated answer should be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits **if this is the only operation**. For example:

   (1.23)(54.321) = 66.81483

   The answer should be rounded to 66.8.

3. When a series of calculations is performed, each interim value should not be rounded before carrying out the next calculation. The final answer should then be rounded to the same number of significant digits as are contained in the quantity with the fewest number of significant digits. For example:

   In determining the value of (1.23)(4.321)/(3.45 – 3.21), three calculations are required:

   a. 3.45 – 3.21 = 0.24

   b. (1.23)(4.321) = 5.31483

   c. 5.31483/0.24 = 22.145125

   [Not 5.31/0.24 = 22.125]

   The value should be rounded to 22.1.

Rounding

1. When the first digit to be dropped is less than or equal to 4, the last digit retained should not be changed. For example:

   1.2345 rounded to three digits is 1.23

2. When the first digit to be dropped is greater than or equal to 5, the last digit retained should be increased by one. For example:

   12.25 rounded to three digits is 12.3

Appendix D

Explanations of Cognitive Levels

Knowledge refers to those behaviours and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material, or phenomena.

Comprehension refers to responses that demonstrate an understanding of the literal message contained in a communication.

Application requires the student to apply an appropriate abstraction (theory, principle, idea, method) to a new situation.

Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypothesis, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis, to distinguish cause-effect relationships from other sequential relationships, and to recognize a writer's viewpoint.

Synthesis is the production of a unique communication. It is the ability to propose ways of testing hypotheses, the ability to design an experiment, the ability to formulate and modify hypotheses, and the ability to make generalizations.

Evaluation is defined as making judgements about the value of ideas, solutions, and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical, or satisfying. Evaluation includes the ability to apply given criteria to judgements of work done, to indicate logical fallacies in arguments, and to compare major theories and generalizations.

Directing Words

Discuss
The word "discuss" will not be used as a directing word on math and science diploma examinations because it is not used consistently to mean a single activity.

The following words are specific in meaning. The corresponding cognitive levels are enclosed in parentheses.

Contrast/Distinguish
Point out the *differences* between two things that have similar or comparable natures. (Analysis)

Compare
Show the character or relative values of two things by pointing out their *similarities* and *differences*. (Analysis and/or Evaluation)

Conclude
State a logical end based on reasoning and/or evidence. (Evaluation)

Criticize
Point out the *merits* and *demerits* of an item or issue. (Analysis and Evaluation)

Define
Provide the essential qualities or meaning of a word or concept. Make distinct and clear by marking out the limits. (Knowledge)

Describe
Give a written account of or represent the characteristics by a figure, model, or picture. (Knowledge)

Design/Plan
Construct a plan, i.e., a detailed sequence of actions, for a specific purpose. (Application and/or Synthesis)

Enumerate
Specify one by one or list in concise form and according to some order. (Knowledge)

Evaluate
Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages. (Analysis and Evaluation)

Explain
Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail. (Comprehension)

How
Show in what manner or way, with what meaning. (Comprehension)

Hypothesize
Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically. (Analysis and Synthesis)

Identify
Recognize and select as having characteristics of. (Knowledge)

Illustrate
Make clear by giving an example. The form of the example must be specified in the question; i.e., word description, sketch, or diagram. (Comprehension and/or Application)

Infer
Form a generalization from sample data; arrive at a conclusion by reasoning from evidence. (Evaluation)

Interpret
Tell the meaning of; present information in a new form that adds meaning to the original data. (Comprehension)

Justify/Show How
Show reasons for or give facts that support a position. (Evaluation)

Outline
Give, in an organized fashion, the essential parts of. The form of the outline must be specified in the question; i.e., lists, flow charts, concept maps. (Knowledge and/or Comprehension)

Predict
Tell in advance on the basis of empirical evidence and/or logic. (Application)

Prove
Establish the truth, validity, or genuineness of something by giving factual evidence or logical reasons. (Evaluation)

Relate
Show logical or causal connection between. (Analysis)

Solve
Give a solution for a problem, i.e., explanation in words and/or numbers. (Analysis and Synthesis)

Summarize
Give a brief account of the main points. (Comprehension)

Trace
Give a step-by-step description of the development. (Knowledge)

Why
Show the cause, reason, or purpose. (Comprehension and/or Synthesis)

Appendix E

Preparing to Write a Science Diploma Examination—What every student should do before the examinations!

1. Prepare a course review schedule:
   - design your schedule for the two-week period (minimum) before the examination
   - divide the course material into sections and indicate on the schedule the time blocks to be devoted to each section
     – take into account the examination blueprint available from your teacher (*Diploma Examinations Program Information Bulletin* for the course). Note that course units are not equally weighted on the diploma examination
     – take into account units/concepts that you find most difficult; i.e., allocate more time for the review of these

2. Obtain and review examination schedules, rules, and policies:
   - record the time and place of writing
   - note minimum and maximum writing times permitted
   - prepare to remain in the examination room for at least 2.5 h (Kleenex, cough drops, etc.)
   - identify materials allowed for writing each examination, such as pencils, pens, calculators, mathematical instruments, and clear plastic ruler

3. Identify and collect examples of each type of question that will be asked:
   - obtain a copy of the relevant information contained in the *Diploma Examinations Program Information Bulletin* for the course (available from your teacher)
   - review the format of previous diploma examinations (available from your teacher)
   - learn the meanings of key "directing" words such as compare, describe, evaluate, explain, illustrate, interpret, justify, prove, and solve

4. Make summaries and point form outlines:
   - distinguish between major concepts and factual details
   - identify essential skills that can be assessed on paper and pencil tests
   - review lab results and procedures—identify connections between lab reports, class notes, and textbook
   - anticipate examples of connections between concepts and the "real world"
   - prepare a glossary of important subject terminology
   - review the data booklet for Chemistry 30 or Physics 30, and review formulas and equations if applicable
   - link each formula or equation with a calculation done on a previous test or assignment
   - identify any restriction on the use of each formula or equation

5. Use memory aids such as:
   - colour coding, underlining, highlighting, jotting keywords in margins
   - numbering points to be memorized
   - grouping word and idea associations
   - reading aloud key words, expressing key words in your own words

6. Review the different question formats and the instructions on how to answer these questions.

Appendix F

Suggestions for Students When Writing Science Diploma Examinations—What every student should know when writing examinations!

1. Do not be afraid to answer each question even if you are not sure of the correct solution to the problem. A penalty is NOT given for guessing on the machine-scored section the exam. Partial marks are often awarded for incomplete answers in the written-response section of the exam.

2. If you are stuck on a question, mark the alternatives that you know are incorrect and choose from the ones that are left using logical guessing strategy. Think of the questions as challenges and cultivate a positive attitude about your ability to answer them.

3. Scan the sets of questions of the examination before answering a particular question. The questions in one set of the examination may jog your memory about a question in another set.

4. When first reading a multiple-choice question, locate and circle key words to help clarify the meaning of the question. Then hide the alternatives and try to formulate an answer of your own. Your answer may be very close to the correct alternative.

5. If a multiple-choice question involves a calculation, do the calculation and select the alternative that is closest to your answer. A multiple-choice calculation is usually short. If you cannot do it in five minutes, your method is either inappropriate or incorrect. Go on.

6. Diagrams on examinations are often labelled with numbers or letters. It may be useful to write in the names of the labelled structures or features that you can identify.

7. When reading graphs, use a clear plastic ruler to more accurately extrapolate or interpolate data.

8. Have a good reason for changing an answer. Do not change an answer on a hunch. Do not waste your time looking for patterns of As, Bs, Cs, or Ds in multiple-choice answers. There are none.

9. You may not have time to write and edit a complete rough copy for each written-response question, but you should prepare an outline of your answer and use it as a guide when writing your good copy.

10. When completing a written-response question, keep in mind the reader of your response. The reader will want to know how well you:
    - understand the problem or the mathematical/science concept
    - can correctly use the mathematics involved
    - can use problem-solving strategies and explain your answer and procedures
    - can communicate your solutions and mathematical/science ideas

11. Rewriting a statement of the question is often a good way to begin a written response. Conclude with a summary statement. Be sure you have clearly explained all assumptions and have verified your conclusions.

12. Keep track of the time and pace yourself. Put a check mark by items that you are uncertain about and return to them if there is time at the end of the examination.

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